

Automating evidence collection for software assurance from existing status reports

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Introduction

- This presentation describes a system developed to extract metrics from an existing status report
 - Provides in-depth data for Evidence-Based Assurance (EBA) and milestone analysis etc.. with no increase in analysts' workload
- Initial analysis toward a traditional IT approach
 - Thoughts behind the change in direction
- Describe the BIWAR report, and how it was already structured to support post-processing
 - Styles, formatting, required identifying elements
- Describe patterns processed by the software
 - Sets of key phrases that point to data
- Flexibility through configurability
 - Maintain search phrases in external configuration files
- Additional ideas using similar techniques



The problem

- The ISS team needed to provide accessible metric data for EBA, while limiting impact to on-going IV&V review and Independent Analysis (IA) work
- The BIWAR had already been identified as a source for EBA data, but it was not really accessible for after-the-fact analysis



Initial analysis and prototyping

- ISS Innovation team was asked to provide analysis/prototyping support for a solution
 - One of the first tasks undertaken
- Initial analysis generated an Operational Concept and data entry screen
 - Defined a process to move the inputs from analyst to lead to report, including modification tracking
 - Defined a template document structure to “mail merge” with input data to generate the report
 - Created a proof of concept to show the idea is feasible
 - Generated a main data entry panel
 - Selection/Entry of “top-level” data for report generation
 - Did not include the lower-level metric data needed for each analysis record



Initial analysis and prototyping (cont'd)

- Example template document

BIWAR

[! section CCS_R14 !]

CCS R14

[! section CCS_R14 milestone !]

During this period, IV&V performed the following milestone reviews for CCS R14.

[! start user data area !]

[! end user data area !]

[! end_section CCS_R14 milestone !]

[! start user data area !]

[! end user data area !]

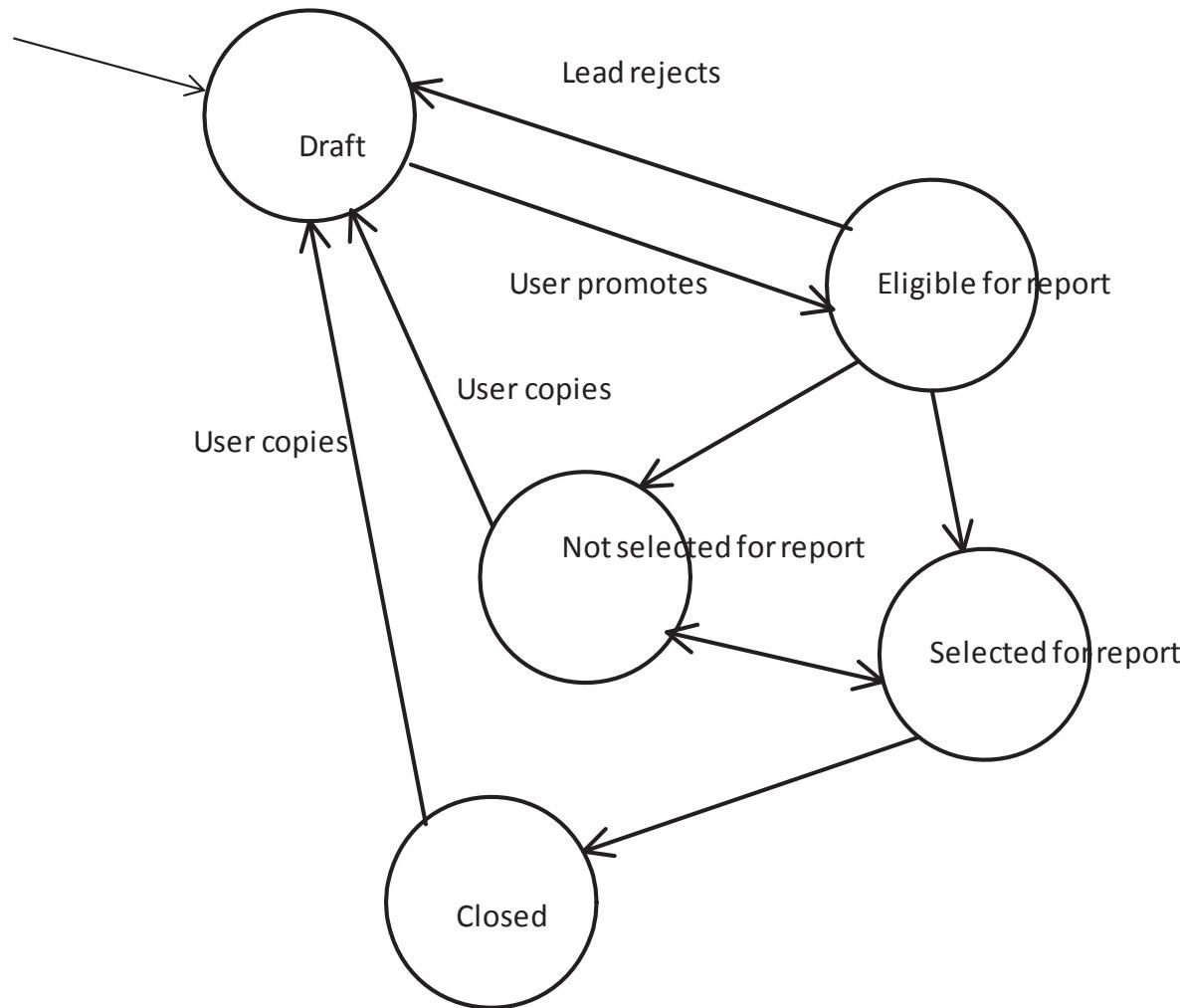
[! end_section CCS_R14 !]



Initial analysis and prototyping (cont'd)

■ State machine

- Analyst inputs, to Team Lead (TL) to report



Initial analysis and prototyping (cont'd)

Workbench data editor

Stage	<input type="button" value=""/>	CSCI	<input type="button" value=""/>	Ver.	<input type="button" value=""/>
PWSR statement	<input type="button" value="Promote"/>				
Section	<input type="button" value=""/>	Date Promoted	<input type="button" value="//"/>	Date Selected	<input type="button" value="//"/>
BIWAR statement	<input type="button" value="Promote"/>				
Section	<input type="button" value=""/>	Date Promoted	<input type="button" value="//"/>	Date Selected	<input type="button" value="//"/>
Review Type	<input type="button" value=""/>	Review Item ID	<input type="button" value=""/>	Review SCR #	<input type="button" value=""/>
Date Created	<input type="button" value="//"/>	Last Modified	<input type="button" value="//"/>		
Created By	<input type="button" value=""/>	Modified By	<input type="button" value=""/>		
<input type="button" value="Save"/>	<input type="button" value="Promote All"/>	<input type="button" value="Cancel"/>			
User Name Here	HH:MM SS MM/DD/YYYY	Record N out of N,NNN	...:		



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Initial analysis and prototyping (cont'd)

- Although the work had progressed, it was far from complete
 - The Operational Concept had defined a fairly complex state machine to manage inputs as they move from analyst to lead to report
 - No work on that had started
 - The data entry screen was display only
 - No implementation behind it
 - Only “top-level” data defined
 - Specific metric data was yet to be defined
 - Another entry screen is needed
 - The current accepted data scheme has 14 columns that were not included in the initial data entry screen



Initial analysis and prototyping (cont'd)

- The next step was to identify the necessary metric data and define how the analyst will enter it
 - Define a data dictionary
 - Define a data entry screen to capture that info
 - Realized the primary source for discovering what data to include was the report we already generate
- Began to recognize usability issues
 - Analysis results entered on a data entry form vs. using Microsoft Word
 - More natural/convenient for the results to be entered in Word
 - Additional work to maintain the data in a new tool
 - Managing yet another work flow
- Something I had written in the Con Ops kept coming back to me
 - The system should be able to reverse itself based on the template
 - So it can go backward from the final report to individual data
 - Very useful for testing if could be done

Could the existing report be mined for data, which is in turn used to generate the metrics database?



Report analysis

- The ISS team has been generating BIWARs basically since the project kicked off
 - The team is already proficient at providing the data in the periodic report
 - BIWAR is accepted as a source of EBA data and Assurance statements for the ISS team
- Each analyst is responsible for providing inputs
 - Funnel up to team leads for final filtering and combination of individual analyst reports into the team report
- Analysts have guidelines defining what must be reported as well as generally accepted formatting standards.
 - If inputs are non-compliant, leads can either update inputs to fit, or kick the report back to the analyst for updates.
 - The team's administrative assistant enforces rules on the paragraph styles as part of producing the final complete ISS report.
- NASA PM is the primary customer for the report
 - With each report a meeting is held to ensure the information in the report is accurate and the analyses performed are understood



Report analysis (cont'd)

- Report contains many metrics used as evidence
 - CSCI revision
 - Assembly Stage
 - IPR and Milestone reviews
 - Review type
 - Artifact reviewed
 - Analyst commentary
 - Related change document
 - Issue counts, dispositions, closure commentary
 - Contributions, Value Statements, Lessons Learned
 - Reports all data mentioned above related to a significant accomplishment by IV&V
 - SCRs reviewed
 - Content list



Report analysis (cont'd)

- The report has a consistent format
 - Styles are used to format the data
 - Also identifies section breaks, and content of data described in the text
 - Analysts use a consistent form
 - SCR 12345, “*The SCR Title*”
 - Specific names used for Milestone and IPR review types
 - References the Program review ID (RCS #, TRSR #, etc..)
- Styles can drive a state machine
- Algorithms can identify metric data based on the phrasing of the text



Report analysis (cont'd)

- Example BIWAR entry

CCS R14

IV&V performed a design/code review for I/O changes related to SCR 41943, “*CCS changes for ICU Modem Ku-Band LOS/AOS Issues*”. IV&V reviewed code and design document changes for this update and found a somewhat confusing or misleading statement in the TLDD related to the Last Loss of Signal (LOS) Override Command. IV&V generated one accepted issue for the review to request an update to clarify that statement and bring it into agreement with the actual implementation.

- Capture the CSCI (CCS R14)

- Capture that the ICU CSCI was also mentioned

- Capture that this was a design and code review

- Capture the SCR number

- Capture the number of issues generated for the review



Report analysis (cont'd)

- Example BIWAR entry

ICU R3

IV&V performed a requirement review for RCS 0108 of SCR 41258 “*Add 1553 Telemetry for USCG39FC3100L Set Function command*”. IV&V noted that a requirement changed to handle the Command_to_Perform_a_Modem_Loopback_Test set part of the new telemetry at the start of command processing and set the rest after the Loopback test completes. There could be an extended period of time between setting the telemetry values, which would make them difficult to track by operators. IV&V generated one issue, PIMS 3660-00002, to report that problem. The issue was accepted and requirements were reorganized to match the planned implementation.

- Capture the ICU R3 CSCI
- Capture this was a requirement review
- Capture the RCS number
- Capture the SCR number
- Capture the number of issues generated



Prototype 2

- A prototype was developed to show that the concept is feasible
 - Reviewed and approved by NASA PM for ISS
- Multiple revisions were made as updated reports were delivered
 - Adding new key phrases and search phrases to capture diverging phrasing noted in successive reports
 - Adding new features for capturing different data as suggested by the Team leads on review.
- Input report is searched paragraph by paragraph for key phrases
 - Related data is captured
 - Simple text search, regular expressions were not needed
- Output data generated in html tabular format
 - Brute force for now, no CSS
- One HTML-formatted output file is generated per report



Prototype 2 (cont'd)

- HTML output designed to be opened in Excel for maintenance
 - Provides extensive data query capabilities with no additional IV&V effort required
 - Allows for manual edits if needed, along with built in commenting so changes are tracked
- Admin personnel can easily merge approved reports into the historical database
 - Provides a measure of version control due to having a single “choke point”



Prototype 2 (cont'd)

Significant Activities Accomplished												
	A	B	C	D	E	F	G	H	I	J	K	L
1	Rpt Date	Team	Activ.	Main CSCI	Other CSCIs	SCRs	RCSs	Tests	TRSRs	Risks	Milestone	Issues
1	6/18/2014	C&C - SARMA SUSARLA	Significant Activities Accomplished	CCS R14	ICU	41943						1 IV cl IC re fo co re C fo th th
2	6/18/2014	C&C - SARMA SUSARLA	Significant Activities Accomplished	ICU R3		41258	108					1 IV 0: U n th C e



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Prototype 2 (cont'd)

	H	I	J	K	L	M	N	O	P	Q	R	S	
1	Tests	TRSRs	Risks	Milestone	Issues	IV&V Activity	IVV SCR #	Reqs Review	Design Review	Code Review	Test Review		
1						1 IV&V performed a design/code review for I/O changes related to SCR 41943, "CCS changes for ICU Modem Ku-Band LOS/AOS Issues". IV&V reviewed code and design document changes for this update and found a somewhat confusing or misleading statement in the TLDD related to the Last Loss of Signal (LOS) Override Command. IV&V generated one accepted issue for the review to request an update to clarify that statement and bring it into agreement with the actual implementation.			X	X			
2						1 IV&V performed a requirement review for RCS 0108 of SCR 41258 "Add 1553 Telemetry for USCG39FC3100L Set Function command". IV&V noted that a requirement changed to handle the Command_to_Perform_a_Modem_Loopback_Test set part of the new telemetry at the start of			X				



Built-In Configurability

- Multiple revisions were made as updated reports are delivered
 - Adding new key phrases and search phrases to capture diverging phraseology noted in successive reports
 - Adding new features for capturing different data as suggested by the Team leads on review.
 - Configurability is KEY for the success of this application
- Configuration data maintained in an external file
 - Application configuration data
 - Key phrases and search patterns
- Easy to add functionality
 - File is tab formatted, plain text, can be modified using any text editor
 - Or can be managed in Excel
 - Set up ranges and selection lists to validate the configuration names
 - Can either export as Tab-delimited file or copy/paste the row data to create the “config.dat” file



Built-In Configurability (cont'd)

The screenshot shows two Microsoft Excel windows side-by-side.

config.xlsx:1 (Top Window):

A	B	C	D	E	F
1 Configuration Name	Configured Value 1	Configured Value 2			
127 ParagraphStyles	ia heading	0			
128 ParagraphStyles	ia header	0			
129 ParagraphStyles	ia title	0			
130 ParagraphStyles	contrib title	1			
131 ParagraphStyles	contribution title	1			
132 ParagraphStyles	value statement 1	1			
133 ParagraphStyles	vs accomplishment	1			
134 ParagraphStyles	lesson learned 1	1			
135 ParagraphStyles	innovation 1	1			
136 ParagraphStyles	success story 1	1			
137 ParagraphStyles	bullet	1			
138 ParagraphStyles	biwar 1	2			
139 ParagraphStyles	biwar 2	3			
140 ParagraphStyles	biwar 3	4			
141 ParagraphStyles	biwar csci	5			
142 ParagraphStyles	normal	6			

config.xlsx:2 (Bottom Window):

A
1 Valid Configuration Names
2 ActivityNames
3 DataDelimiter
4 DropPhrases
5 InputWordDocPath
6 IssueCounterSearchPairs
7 IVV_SCR_Detectors
8 Keywords
9 LeadInParagraphDetectors
10 MaxConsecutiveResyncState
11 OutputColumnWidth
12 OutputColumnWidths
13 OutputFileName
14 OutputFileType
15 OutputHeaderBackgroundColor
16 ParagraphStyles
17 PeerReviewDetectorPairs
18 ReportDateString
19 StartParsingSectionName
20 StopParsingSectionName
21



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Search text patterns

- Analysis identified unique word structures that could be used to locate data in the report
 - Self-identifying – key phrases that are themselves data
 - CSCIs (CCS R13, CCS R14, C2V2, ICU R2, ICU R3, NCS R4, etc..)
 - Milestones (PDR, CDR, TRR, TDR, STRR, etc..)
 - Call-response – key phrases that return a specific value
 - Start/Stop parsing section names (FUNCTIONAL TEAMS = Start, PROJECT MANAGEMENT AND CONTROL = Stop)
 - Paragraph types (biwar 1 = 2, biwar 2 = 3, biwar 3 = 4, etc)
 - Drop phrases (No significant activity, Nothing to report, None to report, etc..)
 - Activity names (Significant Activities, Independent Analysis, Contributions, etc.)
 - Lead-follow – key phrases that signify data to follow
 - Limits word span between leader phrase and follower data and ensures they do not span sentences
 - Artifact names/IDs (SCR, RCS, Test package, etc..)
 - IV&V generated SCRs
 - IV&V Risk #s
 - Lead-follow-trail – pairs of phrases that work in tandem to ID metric data by surrounding it
 - Limits word span between lead/trail phrases, and ensures they do not span sentences
 - Review type detectors ((“IV&V participated in”, “review”), etc..)
 - Issue count detectors ((“IV&V generated”, “new issues”), etc..)

No code change is needed to add/change/delete a pattern because they are defined in the configuration file



Search text patterns (cont'd)

■ Example Lead-trail phrases

IV&V generated SCR

IV&V initiated SCR

IV&V submitted SCR

IV&V created SCR

IV&V Risk

IV&V Risk #

SCR

SCRs

RCS

RCSs

RCSes

TUI

TUIs

TUI#

TUI#s

TUI #s

Test package

test packages

test procedure

test procedures

TRSR

TRSRs



Search text patterns (cont'd)

■ Example Lead-follow-trail phrases

IV&V generated	accepted RID
IV&V identified	accepted RID
IV&V found	accepted RID
IV&V had	accepted RID
IV&V submitted	accepted RID
IV&V generated	issues
IV&V identified	issues
IV&V found	issues
IV&V had	issues
IV&V submitted	issues
IV&V performed the following	review
IV&V performed	review
IV&V participated in	review
IV&V performed the following	reviews
IV&V performed	reviews
IV&V participated in	reviews



Combining paragraphs

- An early challenge to the application was related to a writing style where a lead-in paragraph leads to subsequent detailed information
- There are two formats used:
 1. The subsequent paragraphs all inherit any data mined from the introduction, but each is independent from the other related paragraphs
 2. The introduction and subsequent paragraphs should all be treated as one for data mining purposes



Combining paragraphs (cont'd)

- Example Format 1:

- IV&V performed the following post-FQT test reviews:

- VRC #2014-05, SIF #6708 “CCSR13 PPL 51 and PPL 177 To Provide Payload Timeliner Command Access to Support AMO_EXPRESS”. This VRC contained FQT TUI# CCS_R13-SIF6708.CR-01. This TUI verified the update for PPL 51-Payload Command Request and PPL 177-Payload Adaptation Data for SCR 41963 “PLMDM Command Requirements Required for AMO EXPRESS” and SCR 41920 “CCS PAD PPL to Support Payloads AMO EXPRESS”. IV&V identified two test design discrepancies: 1) incomplete test assumption and constraints, 2) missing test confirmation of check safing response is disabled. FQT accepted and updated the STD document, as recommended.
 - VRC #2014-05, SIF #6755 “CCS R13 PPL 278- Resolve ISS Thermal Control System (ITCS) Range-Check Issue”. This VRC contained FQT TUI# CCS-CDH.DA-04- Range-checking of External Functional Data. This TUI verified the update for PPL 278-Range Check Data for SCR 42032 “Incorrect standard out definitions will pose problems for IFHX leak detection algorithms once range checked”. IV&V found the following discrepancies: 1) verification of the signal PUIs identified in SCR 42032 was not clear from the test design, 2) test results did not latch up with the STD that verified External Functional Data Range Check Error Counter of the Standby or Backup MDM was not reset to zero when the command to clear range check latch data was sent to the Primary MDM. FQT accepted and corrected all issues.



Combining paragraphs (cont'd)

- Example Format 2:
 - IV&V continued code review for SCR 40918 “Implement CR 13047/13231 for International Docking Adapter (IDA)” and SCR 41731 “Implement CR 13231R1 for International Docking Adapter (IDA) in GN&C.” To date, the following have been completed:
 - Review of the changes to two existing modules for detecting and validating new pass-through standard and pass-through data load commands for the VV. IV&V found no issues with these code changes.
 - Review of the changes to two existing modules for activating and deactivating transactions on busses that the IDA interfaces share with the Orbiter Interface Unit/Portable Computer System (OIU/PCS) interfaces. IV&V found no issues with these code changes.



Combining paragraphs (cont'd)

- Format 1 was handled by defining a configuration item to identify the lead-in paragraph by its content
 - Paragraphs starting with
 - IV&V performed the following life-cycle reviews
 - IV&V performed the following design reviews
 - IV&V performed the following code reviews
 - IV&V performed the following test reviews
 - etc.
 - Data is parsed from that paragraph and combined with data parsed from subsequent related paragraphs

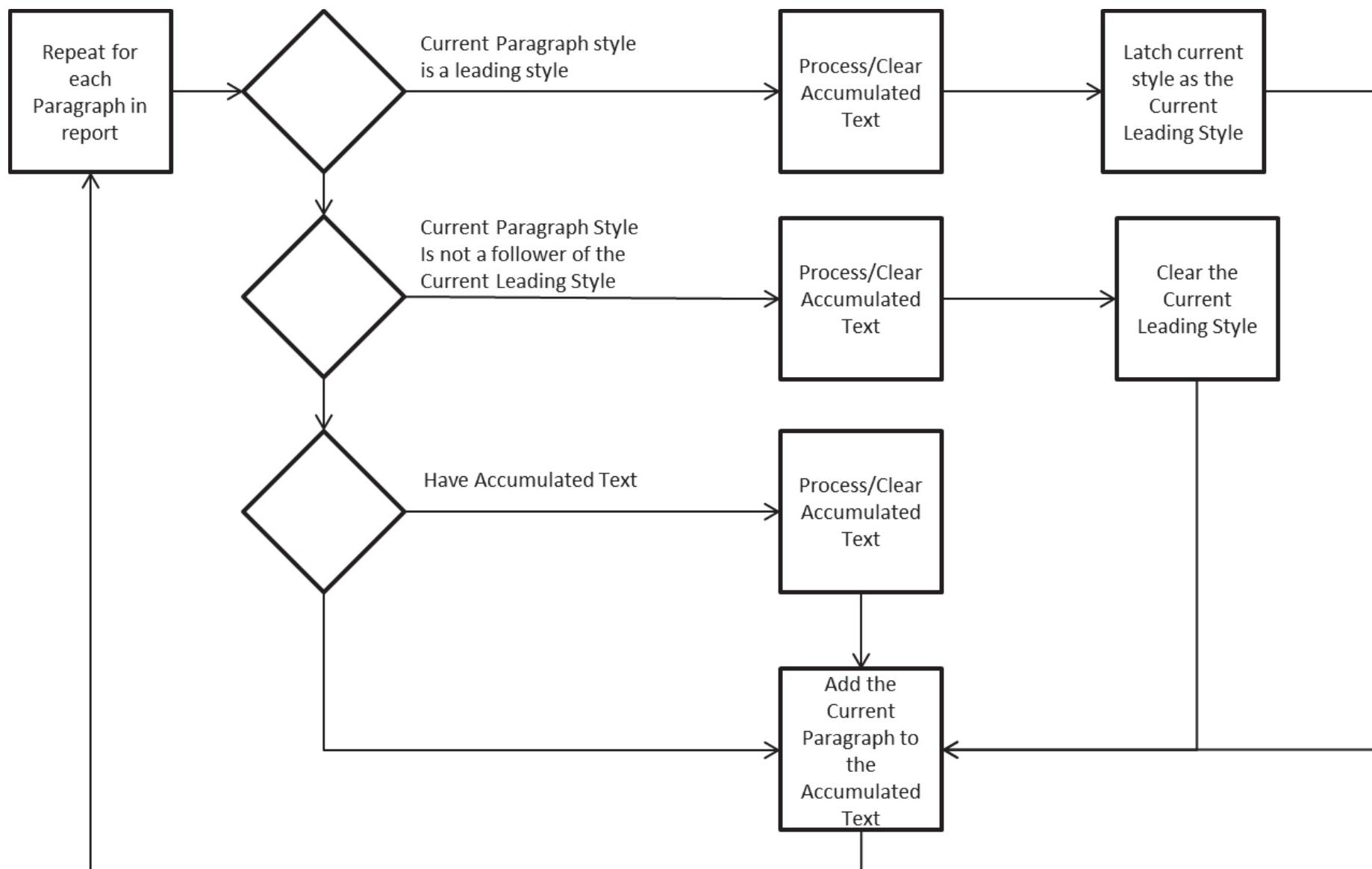


Combining paragraphs (cont'd)

- Format 2 was handled by implementing a data structure and search configuration
 - Loads the Word document, parsing it by paragraph styles into blocks
 - Instead of the top-level paragraph knowing what styles it should combine with, the knowledge was designed into the lower-levels
 - Looks up instead of down
 - Each style is checked with the most recent prior style, and combined if needed



Combining paragraphs (cont'd)



Detecting and capturing plurals

- Needed the ability to recognize plural key phrases and capture multiple following metric data items
 - Ex. "... reviewed Test packages TESTPKG1, TESTPKG2, and TESTPKG3"
 - Test packages is the key phrase
 - TESTPKG1, TESTPKG2, and TESTPKG3 are the metric data items
 - Software was changed to detect plural phrases
 - For plural forms, will accept successive identifiers up to the end of the sentence
 - Word span rules enforced
 - if identifier must be within N words of the key phrase, then multiple identifiers must be within N words of each other
 - Will pick up all 3 identifiers for "... reviewed Test packages TESTPKG1, TESTPKG2, and TESTPKG3" with a span of 2.
 - Would NOT pick up the last identifier in "... reviewed Test packages TESTPKG1, TESTPKG2, and the TESTPKG3" with a span of 2.
 - Discards all punctuation following the data items



Uses for the data

- NASA PM
 - Generating STRR/SMSR/other reporting metrics
- TASC PM
 - Tracking progress toward milestones
- ISS Team leads
 - Managing analyst work
 - Metrics for summary/periodic reports
 - Reviewing past analysis work to apply to similar current situations
 - For example, say that a new SCR is reporting a condition similar to a prior SCR. The IV&V database could be referenced to determine what analysis was performed for the earlier SCR, and use that as a starting point for analyzing the new SCR.
 - Collecting evidence for technical reports
- IV&V analysts
 - Reviewing past work (i.e. look back at STD review when doing test implementation review)



Uses for the data (cont'd)

- The range of data captured, and the inclusion of the original text, provides almost unlimited query capabilities through the Excel interface
- Gathering approximately 100 data records per month, covering all ISS IV&V review



Future possibilities

- Use the key phrases defined by this work to generate text reports from raw data
 - Combine different phrases into styles
 - Allow user to select a style to use, and fill in the missing data
 - Select to use a random style each time to avoid repetitive language
 - Data from spreadsheet to Word document, with no word-smithing needed



Future possibilities (cont'd)

- Understanding Word automation opens doors
 - Two recent examples
 1. Multi-search
 - Search multiple word documents for multiple phrases
 - Builds a “hit list” with clickable links to the document and location
 - Allows user note entry for each hit, with full load and save capabilities
 - Useful for tracking data items across requirements, design, test documentation, as just one example
 - Possible use in generating Tech References?



Future possibilities (cont'd)

2. Input-Output data analysis

- Extracted Input and Output data items from the SRS into a spreadsheet
- Captured all data items that are Output (modified) by more than one function
- Captured all data items that are an Input to one function, and an Output to another
- Used to guide analysis to determine if there is cause for concern in any of the captured data items
- Define tests to verify the software in combination, where the behavior is suspect
 - FQT only verifies functions in isolation so this is a value add by IV&V



Development info

- Other development details:
 - The main application is built in C#, using standard Microsoft Word automation capabilities
 - Microsoft Word 14.0 Object Library
 - The data structure for combining paragraphs is implemented as a set of type-length-value (TLV) elements
 - The TLV is a new concept to ISS, recently introduced via a new project that uses it for configuration data
 - Learning by using
 - php was also used, to convert the TLV data from text to binary format
 - Quickest way to get from point A to point B
 - A Finite-State-Automaton (FSA) is used for the paragraph style search in the TLV data
 - Adapted from “*More Programming Pearls*” by Bentley 1988

